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Engineers' Society of Western Pennsylvania.

This Society does not hold itself responsible for the opinions of its members.

FOURTEENTH ANNUAL MEETING.

Pittsburg, January 16th, 1894.

The fourteenth annual meeting of the Society was held on the evening of January 16th, in the parlor of the Academy of Science and Art, Fifth Street.

Mr. M. J. Becker was in the chair; Mr. R. Clark, Secretary; 49 members were present.

The minutes of the last annual meeting were read and approved.

The reports of the following officers and committees were read and approved:

REPORT OF TREASURER.

For the Year ending January 16, 1894.

Receipts.

1893. January 18.		
Balance,		$240.24
Dues for year ending Jan., 1888 (1),	$5.00	
" " " 1889 (1),	5.00	
" " " 1891 (1),	5.00	
" " " 1892 (3),	15.00	
" " " 1893 (7),	35.00	
" half-year ending Jan., " (6),	15.00	
" year ending Jan., 1894 (55),	275.00	
" " " " (281),	1967.00	
" half-year ending Jan., " (2),	7.00	
" " " " (1),	2.50	
Initiation fees, (30),	150.00	
In part payment of cost of publishing papers,	41.08	
For insertion of advertisements in *Proceedings*,	241.00	
Sale of *Proceedings*,	58.70	
" button badges,	88.00	
Postage and other items refunded,	20.31	
Special subscription to library,	3.00	
		$2933.59
		3173.83

Expenditures.

Printing and binding,	1535.37	
Postage and office expenses,	447.28	
Rent of rooms,	375.00	
Salary of Curator of rooms,	218.75	
Stenographers,	114.75	
Periodicals,	126.88	
Cost of illustrations,	63.30	
Repairs and improvements,	82.60	
Telephone,	26.25	
Insurance,	20.00	
Badge buttons,	100.00	
		$3110.18
Balance,		63.65
		$3173.83

Respectfully submitted,

A. E. Frost,
Treasurer.

REPORT OF THE SECRETARY.

Mr. President and Members of the Engineers' Society of Western Pennsylvania:

Under instructions of the Board of Direction, your Secretary has made full registration of the members of this Society.

The membership is 473.

During the past year forty-three applicants have been elected to membership. Of these, twenty-three are civil engineers, one mining engineer, four mechanical engineers, one electrical engineer, two metallurgical engineers, eight chemists, two architects, one manufacturer. Owing to the new application blanks in use since our last meeting, practically all of these applicants have become members not only by signature, but by paying their initial dues.

Fifteen members have resigned during the past year, most of

these on account of change of residence. It is with deep regret that I have to add to our death-roll the names of Hugo Blank, chemist, died March, 1893; and of E. G. Aikman, died June, 1893.

The papers read before our Society have all been published in our monthly volume of PROCEEDINGS, with full table of contents. At the ten regular meetings held there was an average of 38.5 members present.

Respectfully submitted,

R. NEILSON CLARK, M.E.,
Secretary.

REPORT OF LIBRARY COMMITTEE.

To the President and Members of the Engineers' Society of Western Pennsylvania:

GENTLEMEN: Your Committee on Library begs to report as follows:

During the past year we have had bound 65 volumes of periodicals, etc.; from other sources we have received 93 volumes, making in all 158 volumes added to the library. In addition to this, we have received 59 pamphlets.

The total number of volumes in the library at present is 1766.

Our exchange list has been considerably increased—our correspondents numbering 87 at present, nearly all of whom send us journals, reports or other matter in return for our publications. By this means our previous subscription list has been very much reduced, and we are now paying for only 18 periodicals, nearly all of which are foreign, while the list of publications received has been considerably increased.

Our subscription for the present year for journals already ordered will amount to less than $100.

The work of binding periodicals has been kept up on about the same lines adopted by the committee of the preceding year, and some additions have been made to the list.

A list of books for the library has been prepared, which is fairly complete in some lines, and prices have been obtained from

which it appears that for five or six hundred dollars we can bring ourselves moderately well up to date in the literature of both engineering and chemistry.

H. J. Lewis,
Chairman.

The reports of Special Committees were received and accepted as follows:

The report of Water Committee. It was voted that this Committee be continued.

Report of Committee on Public Roads. Moved and seconded that this Committee be continued also. Carried.

Report of Committee on Programme. Received and accepted.

Report of Committee on Rooms. Received and accepted.

REPORT OF THE RECEPTION COMMITTEE.

The undersigned reports that the Committee has expended the balance of funds in its treasury, amounting to about $120, in placing upon the shelves of the library, Vols. 1 to 13, of the Transactions of the American Society of Civil Engineers; Johnson's work on Framed Structures; and Rand & McNally's General Atlas.

Respectfully submitted,

George S. Davison,
Chairman.

Moved and seconded that this report be received and accepted, and that the thanks of the Society be tendered to the members of the Committee. Carried.

Mr. Alexander Dempster here offered the following resolution:

Resolved, That we show our appreciation of the benefits conferred upon the Society by the self-denying efforts of our retiring Secretary, who in his devotion to promote the best interests of the Society, gave his time and services without money and without price. Carried.

The President then read his annual address. After the reading was concluded, a resolution was offered by Mr. A. Dempster as follows:

Resolved, That our retiring President, M. J. Becker, who has by his genius and application of talent linked his name to the illustrious roll of honor, and of whom our Society is justly proud, deserves our sincere thanks for the benefits conferred upon the Society by the application of his ability to the interests of the Society. Carried by standing vote.

ELECTION OF OFFICERS.

The regular nominees were as follows:

For President, one year, Charles Davis; for Vice-President, two years, William Glyde Wilkins; for Directors, two years, Julian Kennedy and Thomas P. Roberts; for Treasurer, one year, A. E. Frost; for Secretary, one year, Daniel Carhart.

The president appointed as Tellers, Messrs. Meyran, Eastwick and Paine.

As a result of the ballot the President announced the following officers for the ensuing year:

Charles Davis, President; W. G. Wilkins, Vice-President; Julian Kennedy and T. P. Roberts, Directors; A. E. Frost, Treasurer; and Daniel Carhart, Secretary.

R. N. Clark,
Secretary.

PRESIDENT'S ANNUAL ADDRESS.

Fourteen years ago, William Metcalf, Abram Gottlieb, Thomas Rodd, E. M. Butz, N. M. McDowell, Wm. Kent, and J. H. Harlow, applied to Judge Edwin H. Stowe for a charter to incorporate the "Engineers' Society of Western Pennsylvania."

It affords me great pleasure to tell you, and I am quite sure you will be glad to know, that all these worthy incorporators, as well as the Honorable Judge who granted the charter, are still alive and doing well.

The first roll-call was answered by thirty-two members. For a time it was somewhat of a struggle to maintain the organization, to publish the papers, and to defray the current expenses, out of

the scant revenue derived from the limited membership. By persistent and untiring efforts on the part of the more prominent and influential members of the society, some material assistance was obtained through generous and quite liberal contributions from public-spirited citizens; so that, at the end of the first year of its existence, the society had fairly established itself in comfortable quarters, with a moderate nucleus for a library, and a membership numbering 184, nearly all engineers actively engaged in the practice of their profession. At the end of the second year the membership had increased to 244; and from that time forward the society has steadily continued to prosper and grow, until on this day we count 386 in the Engineers' Section, and 82 in the Chemists' Section, making a membership of 468 in all. We have been furnished with comfortable quarters thus far, and we hope in the near future to find a permanent abiding-place. We have a library of 1766 volumes, with numerous pamphlets and many periodicals. Our financial condition is quite satisfactory; we are out of debt, and what few assets we possess are, I believe, happily exempt from municipal taxation; it is true, that we have never accumulated a surplus, but that secures the treasurer against losses of his funds by the possible failure of deposit banks, and it relieves the finance committee of the Board of Directors from all blame on account of injudicious investments.

Of the eleven presidents whom you have honored, during the successive years of the society's existence, with your flattering manifestations of confidence, ten are still living, which seems to indicate that they are selected with special reference to their prominent qualities of endurance; and it also shows that, as a rule, they are not disposed to kill themselves in the performance of their duties for the benefit of the society.

An association like ours, composed, as it is, so largely of men actively engaged in the practical pursuit of their chosen profession, must necessarily exert a beneficial influence throughout the far-reaching ranges of their useful activity; and it is safe to say, that every member, in one way or another, contributes his share, be it ever so modest, towards the development and intellectual improvement of the community in which we dwell. The monuments of

their skilful work are visible everywhere ; and the thousand useful appliances, born of their genius and nursed to active life by their intelligent care, which enhance our domestic comfort and facilitate the conveniences of public intercourse, meet us at every turn.

Nor are the reputations of our members locally confined, by any means. The names of many are well known abroad, and the superior merits of their productions are acknowledged, not only at home, but also in distant countries beyond the limits of our own.

Among our members, we count the proprietors and managers of some of the most extensive iron- and steel-works in the world; vice-presidents, and executive officers, of some of the leading railroads on this continent are on our list; skilled experts in industrial specialties of national reputation, universally recognized as authorities; manufactures in all the various products with which this region of country abounds, and for the successful development of which the needful supplies are most bountifully distributed by nature in this favored locality.

The first president of this Society, who is just retiring from the presidency of the American Society of Civil Engineers, is universally recognized as an authority on all questions relating to the properties of iron and steel, the methods employed in their production, and their peculiarities and behavior under varying conditions. His numerous contributions to the literature of this subject are exceedingly instructive, and are considered valuable standards of their kind and useful sources of information as books of reference.

By far the most satisfactory design for bridging the Hudson River at New York by a structure whose magnitude is made the more imposing by the symmetrical beauty of its graceful architecture has been elaborated, and its practicability demonstrated beyond controversy, by our fellow-member, Gustave Lindenthal, whose professional ability affords every assurance for the successful completion of the work, if the necessary means can be secured to cover the cost of the enterprise. The first bridges in this city, one over the Allegheny river and the other over the Monongahela river, constructed of sufficient strength and rigidity for rapid

transit of vehicles, were designed and built by Mr. Lindenthal, to whom the community is indebted for the saving of time heretofore consumed in the slow movement over the older structures, under the prohibitory admonition of the old familiar sign-board : "$5.00 fine for driving faster than a walk," which notice has now been placed among the legends of the past.

My immediate predecessor stands at the head of a youthful industry, whose far-reaching application it is at this time impossible to foresee. With a supply of raw material literally covering the forty-four states of the Union and all the territories not yet admitted, with the hydraulic force of Niagara's cataract as a motor, and with the all-conquering energy of the senior member of the American Reduction Company as a directing guide, there is no visible limit to its possibilities.

And there is Mr. John A. Brashear, past president of the Society, but still sincerely devoted to its interests, and untiring in his efforts for the promotion of its welfare. To him all praise is due. With manly energy and sublime enthusiasm he has labored unceasingly in the pursuit of his laudable ambition, conquering difficulties and overcoming obstacles most discouraging, mastering the complex theories of a truly exact science, and applying its principles in the creation of instruments of precision, whose perfect workmanship and ingenious features have placed them upon an equal footing with the best works of the most celebrated opticians abroad ; indeed, we need not be surprised if, with the aid of the professor's handiwork, some of his pupils will yet discover some new celestial world which may bear his name, and that this new-found namesake may shine forth clear and bright among the constellations, in memory of our friend, through future ages until the end of time.

Among the members of our Board of Direction we find a man whose name has become a household word throughout the nations of the earth. Every man, woman and child knows him ; the savages from darkest Dahomey and the naked tribes from the South Sea Islands ; the Eskimos from the Polar Sea and the Arabs from the Nubian Desert are telling to their friends at home the wonderful story of the great wheel on the Midway Plaisance of the Col-

umbian Fair. And the man who has designed, constructed, erected and operated this revolving wonder is our good friend and fellow-member, G. W. G. Ferris, of Pittsburg, Pa.

The offices, laboratories, drafting-rooms and workshops of our numerous industrial establishments are filled with our fellow-members, busy men, directing, designing, testing and fitting; working hard, making progress, doing good, benefiting themselves, encouraging others; leaving their footprints in their march of improvement in the direction of higher civilization.

The rivers and streams which cross the highways of commerce throughout this vast country of ours are bridged with thousands of structures, designed, built and erected by our members, with materials manufactured in our midst. Thousands upon thousands of tons of iron and steel produced in our mills are being placed in the elevated railroads and in the lofty modern buildings of our larger cities.

The efficient signal appliances, which contribute so largely to the safety of our increasing railway traffic, are almost wholly supplied from a home establishment, among whose executive officers I recognize some useful members of this Society.

The extensive works engaged in the manufacture of such safety appliances as air-brakes and automatic couplers employ a number of assistants whose names are enrolled on our membership list.

Great credit is due this Society for the recently adopted rule which provides that in the papers read at its meetings all dimensions and quantities shall be expressed in the terms of that system of mensuration known as the "Metric System."

The conversion of the raw materials into useful metals requires the employment of skilled chemists; their professional services are also needed in the refining and classifying of our vast petroleum product, in the manufacture of glass and of pottery ware, and in the application of natural gas for various manufacturing purposes.

The gratifying increase in the membership of the Chemical Section of the Society is evidence of the growing appreciation of scientific methods in our processes of manufacture, without which, indeed, satisfactory economic results are no longer possible.

The Engineers' Society of Western Pennsylvania has every reason for being satisfied with its prosperous condition. It compares favorably in all respects with other similar local associations in the different cities of the country, and the high character of its membership is a promising guaranty for a flourishing future. One of the best means of maintaining the interest of the individuals in the affairs of the Society is the presentation of papers, especially by the younger members, upon practical engineering subjects, giving preference, as much as possible, to topics of local application. Among such themes, allow me to suggest: the smoke problem; the city's water supply; the improvement of the rivers for better navigation; ship canal schemes; business architecture; railway terminals; municipal engineering, etc.

Some of these subjects have been touched upon heretofore, but are by no means exhausted. The agitation, having for its object the abatement of the smoke nuisance, has been maintained with more or less persistence, and the discussion on the subject has been both instructive and entertaining. The aggressive side has been chiefly moved by æsthetic sentiment, while the defense has maintained an attitude resting principally upon utilitarian and economic considerations. Both sides have had their momentary successes and reverses during the conflict, and just now everybody and everything seems to have retired from the field exhausted,—except the smoke.

Our hopes for relief are centered upon the efforts of Mr. Koch to produce a smokeless fuel gas, and upon Mr. Ashworth's reform movement for the higher education of furnace stokers. Let us hope and pray that both these philanthropic gentlemen may succeed, and if they do, the Society will erect monuments in Shenley Park to their memory and forever called them blessed.

The investigations in the direction of an improved water supply for our cities, are in charge of able committees; but this should not deter the members of the Society from expressing their views in the form of suggestions for the consideration of the committee. Certainly, the information so far collected is sufficiently startling to bring the community to a realizing sense of the alarming state of affairs which now exists. When it is shown from indisputable sources of information, that the mortality from typhoid fever, in

the cities of Allegheny and Pittsburg, largely exceeds that of any other city in North America, and is much greater than that of any of the cities of Europe; and that this extraordinary mortality is directly traceable to the impure condition of our water supply, a longer submission to that state of things on the part of the people appears like willful and deliberate suicide; and on the part of the public authorities in charge, it amounts to a criminal neglect of duty, but little short of absolute murder.

What has been accomplished by intelligently directed efforts in London, Paris, Berlin and Vienna, where the death-rate due to typhoid fevers is only from one-tenth to one-fourth of the rate now prevailing in Pittsburg, can be accomplished here as well, and it is hoped that the present agitation, and the movement now well under way, will result in a speedy and thorough reformation.

In regard to the best means of improving the navigation of the Ohio River, the Pittsburg Coal Exchange entertains views not altogether in accord with the professional opinions of the United States Engineers in charge. It may well be a debatable question whether the annual appropriations under the provisions of the River and Harbor Bill have always been judiciously and economically expended, so as to secure the most beneficial results; and while I must necessarily leave to yourselves the discussion of this interesting subject, which has been so well inaugurated at the December meeting by our much esteemed member, Col. T. P. Roberts, who is eminently well qualified by virtue of his extensive experience to speak on this topic; I will here confine myself to the humble suggestion, that if it could be satisfactorily demonstrated to the Coal Exchange, that a barge drawing eight feet of water will not float over a 16-inch ripple without touching bottom, a portion of Uncle Sam's money, now expended in the removal of the debris, might be saved for more useful purposes.

The aspect of the picturesque valley of the beautiful river just now bears a striking resemblance to the wreck-strewn coast of Great Britain as it looked after the destruction of the Spanish Armada.

The project of a ship-canal, connecting the northern lakes with the upper Ohio, presents problems of exceeding interest, not only from an engineering point of view, but also from a commercial

standpoint. Preliminary surveys have been made by a commission, of which our friend, Col. T. P. Roberts, was a member, but the results, as embodied in their report, have not been made public to the profession in sufficiently extensive form to warrant an attempt at a critical review.

The magnitude of the undertaking, the benefits which may be derived from its successful accomplishment, and on the other hand, the serious losses and mortifying disappointments which would result from a failure, justify a careful and exhaustive consideration of the project in all its details. Certainly, there are many members among us well qualified to express their views, and I do not know of a subject of greater local importance. It is, therefore, to be hoped that an early opportunity will be afforded the Society, by those in possession of the facts, to review the problem in all its bearings.

The evolution in the construction of our modern business houses presents some novel and interesting features for our consideration, upon the proper arrangement of which the stability of these structures and the safety of the inmates and contents in a great measure depends. The limits of the altitude of these lofty structures are generally locally determined by the range of efficient fire protection; by the width of the surrounding streets; by the character of the underlying foundations; by the demand for upper-story rooms, and by the return they yield for the invested outlay.

Apprehension has been felt regarding the behavior of heavily-loaded beams and columns when subjected to heat in cases of fire; and some very interesting experiments have been made in Germany, from the published results of which it appears, that unprotected columns, when heated while loaded, readily buckle and collapse; but that by encasing the columns with some non-conducting, fire-proof material, the danger against failure can be very materially reduced.

In the details of the connections between columns and beams; in the attachments of different beams to each other, and in the bearings, where columns rest upon columns, many flagrant defects are noticeable.

The eccentric loading of columns; the transmission of loads

from beams to columns by means of projecting brackets, and similar objectionable practices, need the serious attention of scientific men trained by practical experience.

Plans for railway terminals and for rapid transit systems through the cities and suburbs, present a wide scope for studies ; and there may be some bold critic, with sufficient audacity, to suggest even some possible improvement in the system of municipal engineering as applied to our spasmodic attempts at internal improvements. I did have it in my mind to suggest the further consideration of the condition and improvement of our public highways, but upon reflection I have concluded to let the matter drop. The majority of the people of this community rather like the country roads as they are; and if at any time in the distant future a desire should arise for bettering their condition, the representatives of the people assembled in Harrisburg will adopt such measures of relief, as in their wisdom they may consider as serving the best interests of their constituents; and in this effort they will likely be guided by the plans of the Farmers' Alliance, and duly prompted by the specifications of that infallible exponent of public virtue, the almighty power of the public press.

Now, if there are among us any individuals who know something upon these suggested topics; or if there are among us any individuals who *think* that they know something upon these subjects—and I feel quite sure there are several who think they do—let them come forward and tell us all about them.

It is by the candid and unreserved exchange of our views and experiences; by plain, outspoken but always friendly and unbiased criticisms, that we arrive at the truth; and by taking an active professional interest in the improvements in contemplation, or in progress around us, we will make our presence felt among our fellow-citizens; and in due course of time, as the wisdom of our counsel is demonstrated by the test of experience; while the monuments of our craft are multiplying around us and speak for themselves, we will command the respect and compel the recognition to which the profession is justly entitled.

JANUARY 17TH, 1894.

The regular monthly meeting of the Engineers' Society of Western Pennsylvania took place at the Academy of Arts and Sciences, Pittsburg, Pa., January 16, 1894, Mr. Charles Davis in the chair; forty-nine members present. The meeting was called to order immediately on adjournment of the annual meeting.

The minutes of the last meeting were read and approved with the report of the Board of Direction. The Secretary read the names of six persons proposed for membership.

Balloting then followed for Frank Wilcox, Mechanical Engineer, Messrs. M. Coster and T. P. Roberts being appointed as Tellers. Mr. Wilcox was declared duly elected.

Mr. Gustave Kaufman here moved that the Board of Direction be authorized to secure new quarters for the Society, which was carried.

Adjourned.

DANIEL CARHART,
Secretary.

CHEMICAL SECTION—SECOND ANNUAL MEETING.

PITTSBURG, JANUARY 23D, 1894.

Joseph H. Eastwick, Chairman; James O. Handy, Secretary.

The minutes of the last annual meeting were read and approved. The Secretary reported for the year 1893 as follows:

Number of meetings,	10
Average attendance,	28*
Number of papers read,	13
" " addresses,	3
" " communications,	5

Membership practically constant.

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* 35 per cent.

Prof. Phillips, from the Committee appointed to co-operate with the Chamber of Commerce Committee on the water supply of Pittsburg, reported that the Joint Committee was making good progress, and would shortly be able to make a report on the results of its labors.

Joseph H. Eastwick, the retiring Chairman, delivered an address:

ADDRESS OF THE RETIRING CHAIRMAN.

Fellow-Members of the Chemical Section:

During the past year our meetings have been well attended and much interest taken in the subjects presented for discussion. Necessarily, the principal part of our time has been taken up with matters bearing on the iron and steel industry. I believe much light has been thrown upon methods of analysis. Many papers on new methods have been discussed and valuable suggestions have been made tending to improve methods heretofore in use.

The water supply question has also come under our consideration. The water supply of Pittsburg and Allegheny has many sources of contamination, and chemical examinations have shown that its quality can be much improved. The general health of communities depends much upon their supply of drinking-water. It is a generally accepted theory that disease is propagated by organic matter in drinking-water. Typhoid fever prevails to a large extent both in Pittsburg and Allegheny; in fact, the death-rate from this cause is much larger in these cities than in any other of the cities in this country, and its existence is largely attributed to impure water. It is to be hoped that the efforts now being made by the joint Committee appointed to investigate our present water supply may result in procuring for Pittsburg and Allegheny a good supply of wholesome water.

With the great improvements in the production of steel that have been made in recent years, has also been developed the importance of the chemical composition as determining its physical properties. The use, therefore, of standard methods for the analysis of iron and steel has been justly advocated by many chemists

as a subject of no small importance, and I believe that the time is soon coming when all steel chemists will be forced to adopt some such measure of co-operation if they are to protect their reputations with the commercial and manufacturing world. Experience is proving, more and more every year, that without standard methods of analysis we cannot be sure of standard results. In this connection I might venture an opinion as to what seems to me to be some of the methods combining to the greatest extent accuracy with rapidity. For phosphorus, the precipitation as yellow phospho-molybdate of ammonium, and subsequent titration with either potassium permanganate or caustic soda.

For sulphur in steels, the evolution of the sulphur as H_2S, precipitation as cadmium sulphide and subsequent titration with iodine solution, is by far the most rapid, and has thus far proven to be thoroughly accurate, for the iodine solution, if properly protected, keeps its strength for a long time.

We all know that the color method for carbon cannot always be relied upon, and if we wish to be sure of our results we must resort to a combustion determination.

Beside the scientific advantages derived from our chemical section, the social side has its attractions. We become better acquainted with each other, and in an informal way discuss many subjects. Most all the members of our section are engaged in work at the laboratories connected with the iron and steel works. A few have their attention entirely devoted to other industries, more or less of a chemical nature. It is very desirable that all should take an active part in our meetings; that none of us should hesitate to present papers. We may consider our subject-matter of too trivial a nature, and therefore hesitate to present it in a formal way. This, however, is a mistake. No subject is too trivial that has in it the essence of thought and observation, and no one who occupies himself with chemical work but finds daily new facts presented to him.

I must apologize to you for presenting a subject that may not be of special interest to many of you; it has, however, some points of general interest to chemists, and for a number of years claimed most of my time.

Sulphuric acid, the most important of all chemical manufactures, is my theme, and I propose to give some account of its practical operation and the theories of its formation in the lead chambers proposed by different chemists.

The principal raw materials used in the manufacture of sulphuric acid are: sulphur, either in the shape of Sicilian brimstone or pyrites, and nitrate of soda.

A modern sulphuric acid plant does not differ widely from those in use thirty or forty years ago. Large lead chambers are used now, as then, for holding the gases as they issue from the sulphur-burner, and in these chambers the formation of sulphuric acid goes on uninterruptedly.

A sulphuric acid plant may be said to consist chiefly of the following parts, all of which, with the exception of the sulphur-burner, are constructed principally of lead:

First, the burner in which the sulphur is burned and sulphurous acid formed; then the Glover-tower placed between the sulphur-burner and the first chamber, and connected with these by means of large pipes for conducting the gases; next the lead chambers in which the acid process goes on; and at the end of the set of chambers an absorbing tower, or, as it is called, a "Gay-Lussac tower," whose purpose is to save the nitrous gases escaping from the chambers. In addition, boilers are required for supplying steam to the chambers, air-compressors for elevating the acid, "acid eggs" for holding the acid when subjected to air-pressure, and numerous tanks.

For many years Sicilian brimstone was the raw material used in acid making, and, in fact, would still be in general use were it not for the fluctuating price of that article. The change from brimstone to pyrites has been gradually going on for a number of years. England was the first to use pyrites, and this change is now taking place in all countries where sulphuric acid is manufactured.

The substitution of pyrites for brimstone has, however, some disadvantages, and were it not for the uncertainty of the supply of the latter material it would still be used in preference to pyrites. It is not likely, however, that acid manufacturers will ever return to the use of brimstone, the cost of acid from pyrites being usually much less than that from brimstone.

Some of the disadvantages in the use of pyrites are: the burners required are much more costly than those for brimstone, and the labor required for attending them greater; the chamber space must be greater; the impurities in the acid, such as arsenic, are in some cases objectionable; the wear and tear on the lead-chambers is greater, and the life of the plant necessarily shorter.

When brimstone is used, the construction of the burner is very simple, it being composed of long cast-iron pans enclosed in a chamber, the sides and top of which are made of cast-iron plates bolted together. On these pans the sulphur is burned. In front of the burner are the requisite openings, with doors for charging the brimstone. Here also the pots containing the supply of nitrate of soda are introduced. The nitrate of soda is mixed with sulphuric acid and the nitric acid passes up with the other gases into the chambers. The supply of air for the process is also introduced here.

There are a great many devices for burning pyrites, the prime object of all being to burn out as much of the sulphur as possible with the least cost. It is not, however, practicable to drive out all the sulphur, a small quantity, from two to five per cent. being left in the cinder. Pyrites burners are always built in sets, from 12 to 24 in a set, and the burners are charged alternately each hour, so as to keep up a uniform supply of gas. The whole charge for the burner, about 7 cwt. for twenty-four hours, is introduced at one time. At the end of the twenty-four hours, if the pyrites are exhausted, the cinders are removed and the burner refilled. The pyrites are charged at an opening near the top of the burner, and the nitrate of soda is introduced through a suitable opening in the flue connecting with Glover tower.

Next to the burner is the Glover tower. Through this tower all the hot burner gases pass on their way to the chamber. The object of this tower is to denitrate all the nitrous vitriol coming from the Gay-Lussac tower and also to concentrate a portion of the chamber acid.

The entire space in the chambers is filled wilh gases from the burners, and it is here that the acid formation takes place. The chambers are tight compartments, varying in size, and contain from one hundred to two hundred thousand cubic feet, accord-

ing to the quantity of sulphur burned. It is necessary that the cubical contents of the chambers should be in a certain proportion to the quantity of sulphur burned, and the limit of this proportion is from 20 to 25 cubic feet of chamber space to one pound of sulphur burned in twenty-four hours. The chambers are elevated above the ground at a height of from 10 to 20 feet. The principal chambers are supplied with steam, a jet being introduced at the inlet end of the chamber.

Connected with the last of the set of chambers is the Gay-Lussac, or absorbing, tower, filled with coke; the nitrous gases from the chambers here come in contact with strong acid and are absorbed and returned to the chambers by way of the Glover tower.

In most well-conducted acid works daily tests are made by the chemist in charge. The strength of the burner gas is determined, which, when pyrites is burned, should contain from 7 to 8 per cent. by volume of sulphurous acid; when brimstone is burned, from 10 to 11 per cent. Frequent determinations of the oxygen in the gases escaping from the last chamber into the Gay-Lussac tower will give a very correct idea of the condition of the chambers. The oxygen contained should not vary much from 5 or 6 per cent. A misty red color of the gases in the last chamber indicates good work; a pale color shows that the chambers are working badly.

The nitrosity and the strength of the acids in the chambers and the nitrous vitriol from the Gay-Lussac tower must be regularly observed.

The quantity of nitrate of soda consumed varies from 3 to 6 pounds to 100 pounds of sulphur burned. The yield of hydrated sulphuric acid per pound of sulphur, is between 2.95 and 3 pounds. Theoretically, the yield is 3.06 per pound of sulphur.

The chemical process going on in the chambers has been a subject of much controversy. Many eminent chemists from Berzelius's time to the present day have occupied themselves with this question.

The gases from the burner, usually called burner gases, contain sulphuric acid, oxygen, nitrogen and nitrogen oxides. Sulphur,

when burned in the burner, combines with one volume of oxygen to form one volume of sulphurous acid gas; the volume of air is therefore not increased. Besides the quantity of oxygen necessary to form SO_2 an additional volume is required to oxidize the SO_2 to SO_3. In addition to this, experience has shown that there should be from 5 to 6 per cent. of oxygen in the gases escaping from the last chamber. All this oxygen is introduced into the burner as atmospheric air, that is, in the proportion of 21 parts of oxygen to 79 parts of nitrogen. It has been calculated from the above that the composition of the burner gas, when brimstone is used, is as follows:

	Per cent. by vol.
Sulphurous acid, ...	11.23
Oxygen, ...	9.77
Nitrogen, ...	79.00

When pyrites is used, there is an additional quantity of oxygen necessary to oxidize the iron in the pyrites, and the burner gas is therefore weaker than when brimstone is burned.

Pure pyrites FeS_2 contains: Fe, 46.66 per cent.; S, 53.34 per cent. By calculation we find that the quantity of SO_2 in burner gas from pyrites = 8.59 per cent. by volume. When the burner gas enters the first chamber and comes in contact with aqueous vapor, an energetic action sets in, causing considerable rise in temperature. When the first chamber is the main chamber, the greater part of the sulphuaic acid is made here. The chamber is filled with gases and vapors and throughout its whole extent the action goes on decreasing towards the rear end, the condensed sulphuric acid in the shape of mist gradually settling to the bottom.

Among the more recent investigators of the process going on in the chambers, may be mentioned Lunge, Hurter, Sorel and Raschig.

Probably no other chemist has devoted as much time and thought to investigating this subject as Dr. Lunge. Joint investigations have been carried on by Lunge and Naef and their results have been published in different scientific journals. It is

evident that the oxidation of sulphurous acid does not take place to an appreciable amount by the direct action of the oxygen of the air, and it is equally certain that the oxygen introduced into the chambers in the form of nitrogen oxides does not account for its oxidation, as the total amount of nitrate of soda used, would be sufficient to oxidize only one-twenty-fifth of the SO_2 in the chambers. That N_2O_3 acts in some way as a carrier of the oxygen of the air to oxidize the SO_2 is a theory that has been generally accepted. Theoretically there should be no loss of nitrogen oxides, but as is well known there is in practice a loss amounting to from three to four pounds of nitrate of soda to one hundred pounds of sulphur burned.

According to Lunge's theory the formation of nitroso-sulphuric acid, or chamber crystals, a compound of sulphur-dioxide, nitrogen-trioxide, oxygen and water, forms the basis of the sulphuric acid process in the chambers; these crystals are decomposed by excess of vapor of water, nitrogen-trioxide set free, and H_2SO_4 formed. The reaction takes place according to the following equation:

$$1.\text{—}2SO_2 + N_2O_3 + O + H_2O = \underset{\text{Nitroso-Sulphuric Acid.}}{2SO_2\,(OH)\,(ONO)}$$

$$2.\text{—}2SO_2(OH)(ONO) + H_2O = 2H_2SO_4 + N_2O_3.$$

Nitric oxide together with N_2O_3 has been found in the first chamber near the Glover tower, but its presence there is explained in the following manner:

The temperature in this part of the chamber is greatest and here the chemical action is most intense, and it is probable that here a direct action takes place according to the following:

$$SO_2 + NO_2 + H_2O = H_2SO_4 + NO$$

$$\text{or } SO_2 + N_2O_3\,H_2O = H_2SO_4 + 2NO.$$

The gases in the second chamber have been found to contain only nitrogen-trioxide and not nitric oxide, showing that the presence of the latter in the gases of the first chamber is due to local conditions, and therefore does not deter from the general theory of the acid formation in the chambers.

Lunge expresses the fundamental ideas of his theory as follows: "Sulphur-dioxide combines directly with nitrogen-trioxide, oxygen and a little water to form nitroso-sulphuric acid, which floats in the chamber as a mist; on meeting an excess of water, equally floating about as a mist, the nitroso-sulphuric acid splits up into sulphuric acid, which sinks to the bottom of the chamber, and nitrogen-trioxide, which begins to act anew. Hence, it is not, as hitherto generally assumed, the nitric oxide, NO, but the nitrogen-trioxide, N_2O_3, which acts a carrier of oxygen in the vitrol chamber process."

Loss of nitre in the chambers may be accounted for in several ways. In the first place the recovery of the nitrogen-oxides in the absorbing tower is never complete; secondly, under unfavorable circumstances, the formation of the lower oxides of nitrogen may occur and these not being absorbed by the strong acid in the tower pass out into the air and are lost. In the third place a certain amount of nitric oxide is converted into nitric acid, and is absorbed by the bottom acid and is lost to the process.

Dr. Hurter has presented a theory for the formation of sulphuric acid in the chambers which he calls the dynamic theory. The principle which he makes use of in his theory is deduced from the dynamic theory of gases. His paper is largely of a mathematical nature and is unintelligible to the ordinary reader. I would therefore refer those who wish to pursue the subject further to the original paper.

Sorel's theory differs somewhat from Lunge's, although agreeing with it that nitroso-sulphuric acid plays an important part in the chamber process; he differs from him in attributing the formation of sulphuric acid to a succession of reductions and oxidation of the nitrogen-oxides.

The fact remains, however, that although many eminent chemists have devoted much time to researches in this direction, the formation of sulphuric acid in the lead chambers is still an undecided question.

Innovations in the chamber system have been frequently introduced with the object of attaining the same results with less chamber space, but again and again the new ideas have been aban-

doned, and the chambers of to-day are practically those of forty years ago.

Some of the recent innovations in this direction have been the placing of towers or columns between the chambers. These columns have for their object the more rapid intermingling and cooling of the gases, and by bringing them frequently in contact with surfaces, promoting the formation and condensation of the acid; but in most cases the apparatus employed has been too short-lived on account of the intense action of the hot gases, or the expense of the new arrangement has been too great to warrant the change.

In this connection I may mention an apparatus for saving chamber space called a pipe column, and described in a recent number of the *Journal of the American Chemical Society*. This column is filled with horizontal lead pipes burnt to the sides. It is placed between the different chambers, and the gases passing through it become more intimately mixed, causing a strong reaction to set in. The apparatus is cooled by the air passing through the pipes. It is claimed that the chamber space has been greatly reduced by the introduction of these columns, that the yield of acid is good and that a saving of nitre is effected. They are in use at the Wando Chemical Works at Charleston, S. C.

Another apparatus, contrived by Lunge, called a plate-column, is described in a recent number of the *Journal of the American Chemical Society*, and, it is said, has been successfully applied in connection with the chambers. The column is constructed of a series of earthenware plates containing numerous small openings, and these plates are placed horizontally one above another. The gases entering at the bottom pass upward through the column impinging on the surfaces of the plates. A spray of weak acid is introduced at the top of the column, by which means the acid is greatly cooled. The thorough intermingling of the gases while passing through causes a very rapid formation and condensation of acid. It is claimed that one cubic foot of space in this column is as efficient as two hundred cubic feet in the ordinary chambers. A number of these columns have been tried in different works, but I have not been able to ascertain with what success. Manufacturers are slow to take up with new devices on account of re-

peated failures. If these columns fulfil what is claimed for them they will accomplish a stride in the right direction, and may eventually do away with the large lead chambers.

Before retiring from the chair, I beg to thank you, gentlemen, for the courtesy and good feeling that has been conspicuous at our meetings during the past year.

Let the same earnest efforts and generous rivalry characterize our discussions in the future as in the past; let each in turn step forward and add his mite to our common stock of knowledge. We have done well in the past, and I predict a bright future for the Chemical Section of the Engineers' Society of Western Pennsylvania.

The following officers to serve during the year 1894 were duly elected by ballot:

Chairman, Walter E. Koch; Vice-Chairman, Jas. M. Camp; Secretary, Abram T. Eastwick; Additional Directors, Prof. F. C. Phillips, Jas. O. Handy.

Adjourned.

James O. Handy,
Secretary.

January 23d, 1894.

Regular meeting called to order at 8.55 p.m., after the adjournment of the annual meeting.

Mr. W. E. Koch, Chairman.

Minutes of the last regular meeting were read and approved.

After a few introductory remarks by the chairman, a paper on the "Well, Spring, and River Waters of McKeesport, Pa., and Vicinity," by Theo. Tonnelé, R. B. Carnahan, and Fred. Crabtree, was read by Mr. Carnahan. Discussion followed by Messrs. Koch, Camp, Handy, Roberts, Clark, and Professor Phillips.

THE RIVER, WELL, AND SPRING WATERS OF McKEESPORT, PA., AND VICINITY.

Having had occasion, during the latter part of last year, to make an extensive series of water analyses for the McKeesport Board of Health, for the purpose of obtaining a knowledge of the water supply of McKeesport and vicinity, we have thought it would be of interest or service to the members of the Chemical Section of the Engineers' Society.

There are several points, which came up during the work, that we believe are well worthy of the society's earnest consideration.

The samples represent all the sources of supply—shallow wells, driven wells, springs and rivers, and, in many cases, show their condition at different dates and under different circumstances. The river-water samples included specimens from the Youghiogheny and Monongahela rivers direct, and from the city water-mains.

Shallow Wells.

We thought it worthy of remark that Nos. 1, 2, and 3, although located in the thickly populated section of the city, appear to be excellent drinking waters. Yet, in each case, the conditions seemed to be very unfavorable with regard to liability to surface contamination.

Samples Nos. 1 and 2 were taken after a heavy rain, and No. 3 during a prolonged drought. Previous analyses of No. 2, during a drought gave practically the same results.

This well is situated under a sidewalk of one of the main streets, which is unpaved.

The situation of well No. 5 appears to be more favorable than that of either No. 2 or 3. The situation of No. 6 is about the worst that could be possibly selected, being hardly five feet from a stable.

Driven Wells.

We believe that comparatively high free ammonia and nitrites are characteristic of many driven wells; yet, we were in doubt as to where the limit should be placed in the case of nitrites.

	Sources.	Date.	Condit'n.	Surroundings.	Grains pr. gallon. Total Solids.	Chlorine.	SO_3 in Sulph.	Parts per Million. Free Am'nia	Album. Am'nia	Oxyg'n Consumed.	Nitrogen as Nitrites	Nitrogen as Nitrates.	Temporary Hardness.	Permanent Hardness.	....	....
	Shallow Wells.															
1	Cor. 9th and Market Sts..	8-29-93	Clear.	Fair.	15.34	2.32	2.01	.18	.06	2.34	.002	Trace.	Deg. 11.	Deg. 2.5	....	....
2	Cor. 8th and "	8-31	"	"	28.37	5.22	1.47	Trace.	.02	.78	.003	14.00	10.	....	....	....
3	Cor. 2d St. & Mulb'ry Al...	8-24	"	Poor.	23.43	4.09	7.00	.05	.07	.95	.001	15.08	5.5	....	....	....
4	9th St., between Walnut and Lynd..................	8-21	"	Fair.	26.05	1.86	3.00	.10	.12	1.60	.003	21.66	11.	....	....	....
5a	Point of junc. Yough. & Monongahela	8-21	"	"	....	2.61	5.00	1.82	.05	.96	.035	14.77	....	....	....	....
5b	Point of junc. Yough. & Monongahela..........	8-23	"	"	....	2.44	5.30	2.07	.05	.96	.034	15.00	....	....	....	....
6a	9th St., near Yough.........	8-25	"	Bad.	43.06	10.30	....	.31	.10	2.00	.015	23.0	12.5	8.5	....	....
6b	....	8-29	"	"	....	9.00	....	.45	.20	8.00	.008	....	12.5	8.5	....	....
	Driven Wells.															Depth.
7a	13th and Walnut Sts.......	8-28-93	Clear.	Good.	11.63	1.16	1.01	.20	.03	2.40	.085	6.20	7.5	3.5	....	90 ft.
7b	" "	8-29-93	"	"	....	....	....	.10	.04	.64	.060	5.0	....	....	....	....
8	N. S. W. Office................	8-30-93	"	"	32.79	6.01	3.00	.16	.02	1.47	.107	7.4	16.5	6.5	....	60 ft.
9	N. S. W. Street Plant.......	8-30	Clear, turns turbid.	"	15.36	.29	Tr.	.85	.03	2.24	Trace.	None.	6.	0.	....	104
10	East Park........................	8-29	Bluish.	"	25.35	.52	.68	.20	Trace.	.99	.004	"	0.	0.	....	135
11	Power-house, Market St. and R. Railway...........	8-30	Clear.	"	20.69	.75	Tr.	.36	Trace.	1.06	0.34	"	4.5	0.	....	"
12	Walnut St., near Monongahela Ry....................	9-1	Bluish.	"	108.83	44.36	.35	.39	.03	3.52	.010	Trace.	3.5	0.	....	90
13	McKeesport Ice Co.........	9-2	Clear, turns turbid.	"	15.58	.64	.85	.24	.03	1.28	.012	"	9.	....	....	50
14	Oppenheimer Building...	12-23	Clear, turns turbid.	"	17.85	Tr.	Tr.	.20	.02	....	.001	.25	4.5	....	....	106
15a	T. D. Wood's well..........	8-21	Slightly bluish.	"	10.44	.34	"	.05	.03	.29	.001	.33	9.5	....	....	....
15b	" "	8-31	"	"	13.92	.35	"	.02	.01	.40	.001	Trace.	130	....	....	....

	SPRINGS.															
16	A. W. Wood's farm	8-17-93	Clear.	Good.	14.19	.34	Tr.	Trace.	.01	.38	None.	1.95	10.	....	....	....
17	T. D. Wood's Spring........	8-31	"	"	24.18	.69	.45	.05	.02	.58	.015	Trace.	13.	....	....	....
18	5th Ave. n'r Coursin St...	8-24	"	"	29.53	2.32	....	.02	.02	.30	.001	14.56	15.	6.5	....	....
19	White's Hollow..............	8-24	"	"	14.42	.75	....	.03	.02	.24	.001	2.60	14.	....	....	....
20	E. Park, ne'r German Ch.	9-1	"	Bad.	21.63	1.33	2.0	1.65	.12	2.59	.100	10.0	6.5	4.5	....	....
	RIVERS.															
21	Yough. tap......................	8-16-93	Clear.	Low water.	26.0	.52	12.05	.09	.17	1.47	None.	None.	11..	11.	....	....
22	" "	8-17	"	"	26.9	.52	12.40	.10	.25	1.48	"	"	11.5	11.5	....	....
23	" reservoir, clean'd	8-31	"	"	....	.50	....	.21	.08	1.38	"	"	10	10.	....	....
24	" tap........................	9-22	"	Normal.	....	.35	....	.08	.06	....	"	"	4.5	4.5	....	....
25	" mid-stream, Smithton, Pa.	10-14	"	"	9.51	.23	3.49	.04	.02	....	"	"	3.5	3.5	....	....
26	" mid-stream, West Newton, Pa.	"	"	"	11.14	.23	3.75	.03	.01	....	"	"	"	"	....	....
27	" mid-stream, Alpsville, Pa.	"	"	"	12.78	.23	3.97	.04	.03	....	"	"	4.	4.	....	....
28	" mid-stream, McKeesport pump. sta.....	11-1	"	Abt. norm'l	5.47	.29	2.33	.02	.02	....	"	"	2.5	2.5	....	....
29	Yough. tap	11-1	"	"	5.47	.29	2.33	.03	.02	....	"	"	"	"	....	....
30	Monon. riv., 200 yards above Yough..............	9-2	"	Low water.	....	.52	.98	.04	.25	3.74	"	"	0.	0.	....	....

			GRAINS PER GALLON (231 cubic inches).														
	SOURCES.	Date.	Per Sulphate of Iron.	Sulphate of Alumina.	Sulphate of Lime.	Sulphate of Magnesia.	Sulphate of Soda.	Chloride of Sodium.	Carbonate of Soda.	Carbonate of Lime.	Carbonate of Magnesia.	Carbonate of Iron. Alumina.	Nitrate of Lime.	Nitrate of Magnesia.	Volatile and Organic Matter.	Silica.	Total Solids.
31	Yough. river, tap water..	8-10-93	5.	793	9.52	.500	8.314	.860	....	....	....	....	....	....	.950	.500	26.437
32	" "	8-12	10.	800	12.02	.640	11.40	.960	....	....	....	....	....	....	1.010	.72	37.55
33	" "	11-3	1.32	.450	2.254	.119	1.019	.330	....	....	....	....	....	....	.816	.146	5.236
34	Mckpt. Elec. Lt. Co., 30 ft.	9-29	....	....	3.32	....	....	8.66	....	....	.67	.10	4.18	5.48	....	.80	23.21
35	Oppenheimer Bldg.........	12-23	....	....	....	....	....	Trace.	12.32	4.	32	....	....	....	....	.15	16.79

The two wells giving much the highest nitrites are lowest in free ammonia. Taking into consideration all the results of the above analyses, we see no sufficient reason for condemning any of these wells on nitrites alone.

Well No. 12 is a brine strongly alkaline by carbonate of soda.

Springs.

No. 16 is a spring, four miles from the city limits; No. 18 was discovered in excavating for a building near the heart of the city; No. 20, coming from the side of a hill at the foot of a long slope, is classed as a spring, but, according to analysis, is more properly the result of drainage from the high lands back of it.

Rivers.

The manner in which the albuminoid ammonia came off in the determinations, the other results of the analyses, microscopical examinations of the water, and the decidedly green color of the water, all go to prove that the organic matter in both rivers is chiefly vegetable. There does not appear to be any reason to fear contamination from animal organic matter from towns situated above McKeesport. Although comparatively free from dangerous organic matter, the Youghiogheny river appears to us to be objectionable during the season of very low water, from the fact that at such times it is high in sulphates. At such times the water has a decidedly acid taste, due to the sulphates of iron and alumina, and is unsatisfactory for domestic or cooking purposes.

Great changes in the composition occur in very short periods of time, as will be seen by comparing the dates of the analyses. The sulphates undoubtedly come from the coal measures.

Similar waters are mentioned by Dr. T. Sterry Hunt in his Geological Essays. We believe authorities would sustain us in the opinion that the Youghiogheny river water is good during normal or high water, but is rather objectionable during dry seasons when the water is low and more concentrated.

Mineral Analyses.

We also present a few mineral analyses that may prove of in-

terest. As may be seen, the Youghiogheny river water is not at all good for boiler purposes. The sulphates have much the same effect on the boilers as would a free acid.

No. 34 is noticeable on account of the large amount of nitrates it contains. It gives but little scale and causes no corrosion. The well is only 32 feet deep, and appears to be connected with some large subterranean reservoir.

No. 35 is from a driven well, and is said to give very good results in boilers.

In making the above analyses we believe we have used the most approved methods.

We used in the case of nitrates the sulphophenic acid method, and for nitrites the sulphanilic-naphthylamine hydrochloride method.

In determining oxygen consumed we proceeded as follows: To 250 c.c. of the water, add 20 c.c. sulphuric acid (1 part acid to 3 of water) and 20 c.c. permanganate solution (.315 grammes to the litre). Boil exactly five minutes; determine excess of permanganate with oxalic acid solution of equivalent strength.

THEODORE TONNELÉ,
ROBT. B. CARNAHAN, JR.,
FRED. CRABTREE.

DISCUSSION.

THE CHAIRMAN: The interest of this paper is very great, and the few remarks Mr. Carnahan has made give but a faint idea of the amount of work that has been done upon it. It would take considerable time to examine carefully everything in it, but it is well worth doing so. Some of these analyses are very interesting, especially those of waters with nitrates of calcium and nitrates of magnesium. I would like to hear the opinion of some of the gentlemen present as to the origin of the nitrates in these waters. It is easy enough to account for a sulphate, which, of course, comes from the pyrites in the coal measures. Bischof found that out years ago. But I am not so sure about the origin of the nitrates. I do not know whether there is any soil in this vicinity with nitre in it, but I believe that the soil in certain geological

formations does contain nitre. I would like to hear something on that subject.

R. B. CARNAHAN, JR.: The well of which you have just spoken is one of the most peculiar wells that I have ever seen. The McKeesport Electric Light Company use the water from it in their boilers. They have a small pump with quite a good capacity connected with it, and when they pump the water down to a certain point, two very strong streams of water can be seen flowing in. I thought at first, before I examined it, that it had a connection with the river, but the water is totally different from the river water—as different as any two waters could be, almost—and I cannot imagine where the water comes from. I might say, that at a depth of 30 feet in McKeesport, quicksand can be struck at almost any place in the low-lying ground along the Youghiogheny or Monongahela rivers, and this water is in the quicksand.

MR. JAMES M. CAMP: I made an analysis of the water from a driven well in the yard of the Duquesne Steel Works, about two miles from McKeesport, and found it to be very high in free ammonia, but contained only a trace of nitrates. There is also a driven well in the Superintendent's residence. The water of that well is so contaminated with carbonates of soda and potash that it cannot be used. His residence is on the top of a hill, and I think the well is 150 feet deep, which would make it about 100 feet deep on the level.

MR. J. O. HANDY: I know that carbonate of soda is a very common constituent of waters in this vicinity, and I have often wondered where it comes from. The carbonate of soda often runs up to 30 grains to the gallon. It is found in waters over a wide area,—at West Newton, at Manor Station on the Pennsylvania Railroad, in springs at Swissvale, and in quite a number of places in this locality. It is not always associated with salt; in fact, salt waters contain comparatively little carbonate of soda. Salt waters contain very high free ammonia, according to my experience, but contain practically no nitrates or nitrites. The free ammonia is apparently without significance; it probably comes from the nitrogen of the coal.

Prof. F. C. Phillips: I could never see why the nitrites in water of very deep wells were considered by some authorities to be so dangerous. If it is found in the water of shallow wells, where there is some obvious source of pollution, it is another matter. I would like to know from some one why the nitrites in water of deep wells are considered so dangerous. If it is a round of changes, the nitrites seem to represent that stage of change that is of the shortest duration; that is to say, the change to ammonia seems to be slow; the nitrogen accumulates as ammonia, then it passes rapidly through the condition of nitrites and then into the stage of nitrates, and remains in that condition for a considerable time. The changes are perfectly obvious, and I believe all of them are due to germs, but they go on in very deep strata probably as well as on the surface, when air is present. Why the nitrites in such cases should be considered dangerous, I can hardly conceive.

R. B. Carnahan, Jr.: I think it is altogether probable that nitrites, as Dr. Fox remarks in his book on *Water Analysis*, are formed by the reduction of the nitrates by sulphuretted hydrogen, for instance, or some other reducing gas, or a reducing mineral of some kind. I think if you would find a water fairly high in nitrates and nitrites, it would look very much as though that had been a reduction from nitrates to nitrites, in a driven well so deep that no organic matter would get into it. It seems to me it could be solved in that way; whether the right solution or not, I do not know, but it looks plausible.

The Chairman: It is a question whether there is any water really free from organic matter.

Mr. T. P. Roberts: I understand these analyses were made for the McKeesport Board of Health, and I would like to ask whether the health of McKeesport has been visibly affected by the water supply from the Youghiogheny River. I know from observation that the river changes its color from time to time,—sometimes it is quite clear, due, I think, to the action of the sulphuric acid waters coming from the mines, and particularly from the coal washers at Jacob's Creek. I referred to that matter a year or so ago in a paper read before the Engineers' Society. In

recent years, this sulphur seems to come in greater volume than formerly. We notice at Lock No. 1, the Monongahela River is so clear at times that the bed of the river can be seen at a depth of 11 or 12 feet. Formerly that condition of the river was never known. Bottles of the water can be kept for months and show no sediment. I have always observed that at times when the river was so very remarkably transparent the fish do not seem to flourish very well.

R. B. Carnahan, Jr.: I think the health of McKeesport is ordinarily good. The percentage of typhoid fever is about one-half that of Pittsburg.

The Chairman: Sulphur is a very good disinfectant.

R. B. Carnahan, Jr.: There is one thing about the water which has been discussed a great deal. In the middle of the year the water will have a strong acid taste; in fact, put sugar in it, and you could almost imagine you had lemonade. In trying to make tea out of it, you will get ink. It is very hard on boilers indeed. The manufacturers are overcoming that by drilling deep wells and getting an alkaline water. You can get quite a strong alkaline water at a depth of about 100 feet. Neutralizing the Youhiogheny river water with this water stops the corrosion of the boilers almost completely.

Mr. T. P. Roberts: I have heard a great many discussions on the committee that I have been connected with since last spring, and I have always understood that water giving an acid reaction is fatal to vegetable life and to bacteria of vegetable origin, such as the cholera and typhoid germs. A very slight acid reaction seems to be fatal to them, while they will flourish in an alkaline water. I do not think it could be claimed that water slightly acidulated could develop and nourish any pathogenic germs. I do not think they could exist in an acidulated water. If I am not right in this conclusion, then I am certainly wrong in some of my statements that I have made in regard to the Monongahela river water as a source of water-supply, although I admit that it is susceptible of improvement at times during the year; it is only occasionally that this phenomenon I refer to occurs.

Prof. F. C. Phillips: Sulphates of alumina and iron clarify the water and make it favorable for certain kinds of plant growth, which may account for the greenish color of the water.

The Chairman: There is no doubt but that sulphate of iron is a good disinfectant and a good clarifier.

Prof. Phillips exhibited some mounted specimens of artificial crystals.

Meeting adjourned at 9.30. Number of members present, 18.

A. T. Eastwick,
Secretary.